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Evaluation of nutrient and anti-nutrient content of both raw and processed velvet bean seed *(Mucuna sloanei)*

Ewa, U. E., Akinmutimi, A. H., Ojewola, G. S. and *Onunkwo, D. N.
Department of Animal Nutrition and Forage Science,
College of Animal Science and Production,
Michael Okpara University of Agriculture, Umudike
*Corresponding author email: donunkwo1@gmail.com, +2348033388622

Abstract

*The nutrient and anti-nutrient content of raw, boiled, and boiled with potassium sesquioxide (akanwu) Mucuna sloanei seed meal (MSSM) were investigated. A total of 120 day old broiler chickens were used. There were 4 treatments each replicated into 3 with 10 birds per replicate in a completely randomized design (CRD). Four treatment diets were formulated. Diet 1 served as control containing raw Mucunal, while diets 2, 3, and 4 had boiled Mucuna, Mucuna boiled with ankanwu and boiled Mucuna mix with enzyme, respectively added to them at 5% level of inclusion. The birds were allowed 7 days to get stabilized before being randomly assigned to the experimental diets that lasted for 49 days.The crude protein content of the raw was significantly higher (P<0.05) than that of the boiled and boiled with potash. Processing reduced the energy content of raw Mucuna seed from 4.73 Kcal/g (raw) to 3.90 Kcal/g (boiled) and 3.81 Kcal/g (boiled with akanwu, BWA). Boiled MSSM had a significantly (P< 0.05) higher content of Na, K, Ca, P and Mg, than that of BWA. The calcium (1.87) content of the boiled was significantly (P< 0.05) higher than that of the raw (1.665). There were significant (P<0.05) increases in Fe, Cu, Zn and Mn in the processed over the raw. BWA resulted in a significantly (P<0.05) higher decrease in anti-nutritional content of the seed. B*oiling method is selected as the best method of detoxification for *Mucuna sloanei* seeds since it was able to make 84.18% reduction of L-DOPA which is the major anti-nutrient in *Mucuna* and 98.40% reduction of trypsin inhibitor a wide spread anti-nutrient among legumes. In addition it is amethod of detoxification that can be well adapted to by the local farmers as against that of boiling with potash (*akanwu*) which involves the preparing of potash solution and additional cost.

Keywords: Raw, boiled, *Mucuna sloanei*, potassium *sesquioxide*, processing, nutrient, anti-nutrient

Introduction

The main limitation to further expansion of poultry industry is the availability of needed feed ingredients at reasonable prices (Ani and Okorie, 2005; Babatunde and Hamzat, 2005). The high cost of feed is due mainly to competition between man and livestock for conventional feed ingredients like soybean seed meal and groundnut seed meal (Adegbola, 1990; Emenalom, 2004; Akintunde *et al*., 2013). One of the promising ways to solving the above is to identify cheaper and available feed stuffs that are of low human preference and little or no industrial use that can meet nutritional requirements of poultry with or without processing (Akinmutimi *et al*., 2011; Amaefule *et al*., 2013).

One of the grain legumes that have such potential is velvet beam (*Mucuna sloanei)* *(*Akinmutimi *et al*., 2011). The seed of *Mucuna sloanei* is highly resistant to diseases and pest, and exhibit good nutritional qualities. It yields about 0.8-2 tons of seeds/hectare with crude protein content of about 28% and high energy of about 2.71kcal/g (Akinmutimi *et al.*, 2011). It is relatively high in lysine content and compares favourably in terms of methionine content with soya bean meal, making it a potential source of protein for livestock and poultry (Sridhar and Bhat, 2007). But *Mucuna* species are known to contain anti-nutritional factors such as L-DOPA, trypsin inhibitors, tannin and cyanogenic glycoside (Carew *et al.*, 2003b; Akinmutimi and Ukpabi, 2008). This normally cause neurologic effect such as dizziness, nervousness, and poor growth and lastly mortality of birds (Akinmutimi *et al.*, 2011), thus the need for processing before use. This therefore has led to the need to determining the chemical composition ofboth raw and processed forms of the *Mucuna sloanei* seed before use in broiler diets to reduce mortality and improve growth performance of birds.

Materials and methods

Mucuna sloanei seed (Ukpo) was purchased in Aba main market in Abia State, Nigeria.

The following methods were used in processing of *Mucuna* seed.

Preparation of test ingredients

Boiling in water for 30 minutes

The ratio of liquid to solute was 2:1 (i.e2litre of water was used for 1kg of *Mucuna* seed). The seed was added into the water at boiling point and allowed to boil for 30 minutes after which the heat was removed the water decanted and the seed dried and milled to pass through 2milimeter sieve, bagged and stored for use in feed formulation for the broiler chicken

Boiling with potash (akanwu) in water for 30 minutes

The same procedure used for boiling was applied here. But in addition potash was added at 5% of the liquid (water) as*Mucuna* seeds were introduced into the boilingwater for 30 minutes.

The proximate composition of raw and variously processed forms of *Mucuna* seed meals were determined using the procedure described by the Association of Official Analytical Chemist (AOAC, 1995). The gross energy was determined using adiabatic bomb calorimeter,

Mineral determination

Mineral determinations of both raw and variously processed *Mucuna* seed meals were done using the method of Johnson and Ultrich (1959). The different samples of processed and raw *Mucuna* seed were digested in hydrochloric and nitric acids. After the dilution, the minerals Na, K, Ca, Mg, P were determined by flame photometer, Cu, Zn, Fe, Mn were determined by atomic absorption spectrophotometer using buck 600 AAS.

Anti-nutritional factors determination

L-DOPA determination was by the method of A.O.A.C. (1995), trypsin inhibitor was carried out according to the procedure outlined by Kakade *et al*. (1974). Saponin content of raw and variously processed *Mucuna* determined according to theBruner (1985) (spectrophotometric method) while hydrocyanic acid was determined according to the method of Knowles *et al*. (1990)

Results and discussion

Theproximate composition and gross energy contents of raw and variously processed *Mucuna sloanei* seed meal are presented in Table1. There was significant difference ($P < 0.05$) between the raw and the processed seed meals for all the parameters considered. The crude protein value ranged from 27.88% in boiled with *akanwu* to 29.03% in the raw.

Table 1: Proximate and gross energy composition of raw and processed *Mucuna sloanei* seed meal

Nutrients	Raw	Boiled	Boiled with akanwu(BWA)	SEM
Dry matter (%)	91.15^b	90.42^c	91.52^a	0.16
Crude Protein (%)	29.03^a	28.92^b	27.88^c	1.85
Crude fat (%)	5.39^a	2.08^b	1.87^c	0.57
Crude fibre (%)	5.76^c	8.35^a	7.84^b	0.40
Ash (%)	3.94^b	4.60^a	3.90^b	0.11
Nitrogen free extract (%)	55.88^c	56.59^b	58.51^a	0.42
Gross Energy (Kcal/g)	4.73^a	3.90^b	3.81^b	0.19

Means within the same row with different superscripts (^{a} – ^{c}) are significantly (P<0.05) different.SEM- Standard error of mean

The crude protein value (29.03%) obtained in the raw seed was similar to values (30.68%; 27.4%*;* 27.90%) that have been previously reported by Ekwe (2012) Ukachukwu *et al*. (2002); Olomu (2011), respectively This high crude protein makes the seed a potential supplement to cereal based diet with low protein value of 8.55% crude protein (Akinmutimi, 2004). There were reductions in the crude protein values for the various processing methods as noticed in boiled (28.29%) and boiled with akanwu (27.88) were due to double degradation which might have leadto theleaching of nutrients (Akinmutimi, 2004). The high value of boiled over that of boiled with *akanwu* can be attributed to the effect of double degradation and hence more loss of nitrogenous contents (Akinmutimi, 2004). Reduction in crude protein content as a result of processing is in line with previous findings by Eburuaja(2010) andEkwe (2012) that processing reduces the crude protein values of African yam bean and *Mucuna sloanei* seed meal, respectively.

There were significant differences (P< 0.05) for crude fibre content between the raw and the processed and among the various processing methods. The crude fibre ranged between 5.76 for raw and 8.35% for boiled. The crude fibre content obtained for the raw was slightly lower than the value (6.5-7.1%) reported by Ukachukwu *et al.* (2002) and 7.7% reported by Iyayi and Egbarevba (1998). This may be due to differences in geographical sources of the seed (Akinmutimi, 2004). The seemingly lower crude fibre value (7.84%) for boiled with akanwu can be attributed to double degradation. The slightly higher crude fibre content observed in the boiled could be as a result of the seed coat incorporated in the feed stuff though this still fall within the range of inclusion for broiler ration, therefore does not make it unacceptable for inclusion in the ration of farm animal (Togun *et al.*, 2007), more so when fed with other ingredients or at low dietary level of inclusion. Fibre acts as a diluent but its absence in the diet leads to incidence of wide range of diseases including diabetes Miletus (Oke *et al.*, 1996)

The raw had the highest (P<0.05) value (5.39%) for ether extract followed by the boiled (2.08%) and lastly by boiled with *akanwu* (1.87%). The significantly (P<0.05) lower value of the processed to the raw could be attributed to effect of heat during processing which causes some volatile fatty acid to escape. The values obtained were lower than that of raw (6.18), and boiled (6.64) reported by Ekwe (2012). This could be attributed todifferent sources of the ingredients and possibly processing method. The boiled had higher (P<0.05) ether extract value than that of the boiled with *akanwu*, this would make it to have better feed efficiency as well as growth. This is because, fat increases the utilization of dietary energy because it has low heat increment of feeding and also slows down the rate of passage of feed through the gastro intestinal tract (Olomu, 2011). The 2.08% ether extract obtained for the boiled is higher than the value recorded for conventional feed stuffs by Olomu (2011) for soyabean meal (1.50) and soya seed meal (1.10%) and slightly lower than that of groundnut meal (3.50) thereby making the boiled *Mucuna* seed meal an acceptable protein supplement for broiler production.

The nitrogen free extract (NFE) values showed significant ($P<0.05$) difference across all the observations. The NFE values were 55.83% for raw, 56.66% for boiled and 58.51% for boiled with akanwu. The raw had lowest ($P<0.05$) value compared to those of the processed. This is in line with report of Ekwe (2012). The significantly ($P < 0.05$) higher value of boiled with *akanwu* over the raw and boiled only could be attributed to double degradation resulting in leaching of other nutrients and hence lower values since NFE = 100-(others) hence boiled with akanwu will have higher total digestible nutrient ((TDN) because the higher the NFE the higher the TDN (Eburuaja, 2010). The gross energy value 4.73Kcal/g for raw seeds was significantly ($P<0.05$) higher than the processed seeds which is in line with the reports by many researchers (Akinmutimi, 2004; Eburuaja, 2010; Ekwe, 2012). This has been attributed to the effect of processing. The significantly ($P<0.05$) lowest value of boiled with *akanwu* may be due to double degradation, loss of energy related nutrients such as ether extract during processing and hence loss of energy (Eburuaja, 2010). Within the processed seeds, boiled seed had the highest gross energy (GE), which could be due to the high content of ether extract in the boiled seed (Table 1). The ash content of the boiled (4.60%) was significantly ($P<0.05$) higher than that of the raw (3.94%) and the boiled with akanwu (3.90%). The value is lower than that of soya bean meal (8.00%) and soya seed meal (8.00%) reported by Olomu (2011). The significantly ($P<0.05$) higher value of boiled over the rawwas contrary to that reported by Ukachukwu *et al*. (1999) and Ekwe (2012), where values for the raw werehigher than those of the boiled. The significantly ($P<0.05$) higher value of the boiled seed over the raw with the exception of the boiled with *akanwu* can be attributed to concentration of minerals solids as the liquid evaporates during boiling.

Boiling of the *Mucuna* seed alone could be considered as the best processing method in terms of proximate composition and energy since it gave the highest value for crude protein, crude ether, ash and energy.

Themineral composition of raw and processed *Mucuna sloanei* seed meal is presented in Table 2. There were significant differences ($P<0.05$) in all the parameters considered. Thesodium content of the boiled was significantly ($P<0.05$) higher than that of the boiled with *akanwu* but was not statistically ($P< 0.05$) different from that of the raw.This disagrees with the results of Akinmutimi (2004) and Ekwe (2012) who reported higher ($P<0.05$) sodium content in boiled than that of raw.

Table 2: Mineral composition of raw and processed *Mucuna sloanei* seed meal

Mineral (%)	Raw	Boiled	Boiled with akanwu(BWA)	SEM
Macro minerals				
Sodium	0.07[a]	0.07[a]	0.06[b]	0.01
Potassium	1.35[a]	1,28[b]	1.18[c]	0.03
Calcium	1.67[c]	1.89[a]	1.69[b]	0.03
Magnesium	1.23[a]	0.25[b]	0.20[c]	0.17
Phosphorus	1.87[a]	0.27[b]	0.22[c]	0.27
Micro-minerals				
Iron	57.65[c]	69.87[a]	66.50[b]	0.20
Copper	16.75[c]	19.70[a]	18.27[b]	0.27
Zinc	13.88[c]	29.70[a]	25.97[b]	2.39
Manganese	6.85[c]	33.67[a]	31.80[b]	4.34

Means within the same row with different superscripts ([a] –[c]) are significantly (P< 0.05) different .SEM- Standard error of mean

Table salt is added to broiler ration at the rate of 0.25% (Olomu, 2011) therefore choosing the boiledseeds will lead to the reduction in the quantity of salt used thereby reducing the cost of production of broilers (Eburuaja, 2010).The importance of sodium in broiler production cannot be overemphasized. Olomu (2011) outlined the side effect of Na deficiency in poultry production as reduced appetite and growth rate,decreased egg production and egg size,increased cannibalism, deprived appetite,muscular dystrophy and poor bone growth,lung infection and adrenal hypertrophy, gonadal inactivity and retarded sexual maturity, decrease in plasma and special fluid volumes, change in eye structure, inability to deposit fat and death in prolonged cases of deficiency. Boiled seeds had the highest value (1.87) of calcium that was significantly (P<0.05) different to that of raw (1.66%) and that of BWA (1.69%). This result agrees with that reported by Ekwe (2012). The significantly (P<0.05) high value of calcium in the boiled has a lot of benefits in broiler production. According to Olomu (2011), calcium helps in bone formation, it is also important in blood clotting and muscle contraction, Calcium is involved in enzyme reaction, hormonal signal transmission, glucose metabolism, release of neuro transmitters and membrane integrity and excitability, it helps to regulate the acid base statutes of blood, aids hormone secretion and cell division, Calcium is closely bound to phospholipids in cell membrane where it controls the permeability of membrane and regulates the uptake of nutrients by the cell. In poultry calcium is important in the formation of egg shells which consist almost entirely (about 95 %) of calcium carbonate (Olomu, 2011). The raw had a significantly (P<0.05) higher values for potassium (1, 35%), magnesium (1.87%) over the processed. This can be attributed to degradation during boiling (Eburuaja, 2010).

Between the two processing methods, boiled contained potassium- 1.28%, magnesium- 0.27%, and phosphorus- 0.27%,which were significantly (P<0.05) higher than potassium- 1.17%, magnesium- 0.20%, and phosphors- 0.22% in BWA. The quantities of these nutrients (potassium, phosphorus and magnesium) as contained in the boiled are able to meet with the nutrient requirement of broilers (Olomu, 2011). Potassium in combination with sodium chloride has the main function of maintaining acid base and ionic balance (osmotic pressure regulation) of blood fluid.

While phosphorus and magnesium in the presence of calcium have the major function of bone formation in the body of broiler birds (Olomu, 2011). For the micro minerals namely iron, copper, zinc and manganese, the boiled seed had the highest concentrations which were 69.86%, 19.70% and 33.67%, respectively. This is in agreement with the result of Ekwe (2012) who reported higher values of these minerals in boiled seeds over the raw and other processing methods used for *Mucuna sloanei* seed. Thus on the average, boiled seed have the highest concentration for most of macro and micro minerals.

The anti-nutrtional factors obtained in both raw and processed seeds are shown in Table 3.

There were significant (P<0.05) differences between the raw and the processed seeds for all the parameters considered. Also, there were general reductions in the content of anti- nutritional factors as a result of processing. Seeds boiled in water with *akanwu* had the highest significant (P< 0.05) percentage reduction in all the parameters considered. This can be attributed to double degradation of the anti-nutritional factors (Eburuaja, 2010).The significant (P< 0.05)reduction (P< 0.05) for L-DOPA observed in the processed over the raw showed that processing has effect on L-DOPA reduction in *Mucuna sloanei* seed. This is in agreement with the report of Ekwe (2012); Ukachukwu and Szabo (2003) that boiled *Mucuna* seeds in ordinary water or in water with additives resulted in appreciable reduction of L-DOPA. L-DOPA was reduced from 2.68% to 0.42% (ie.84.18%) after boiling and to 0.25% (i.e. 90.83%) after boiling with *akanwu*. The trypsin inhibitor (TI) in the raw seed was 23.67 %. The TI was significant (P<0.05) reduced to 0.38 (ie. 98.40%) in the boiled and 0.17% (ie.99.30%) in the boiled with *akanwu*. This agrees with the reports of other researchers that TI are heat labile and the use of heat treatment can easily inactivate them (Liener and Kakade, 1980; Akanji*et al*., 2003; Akinmutimi, 2004; Eburuaja, 2010). This implies that birds fed boiled *Mucunasloanei* seed and seeds boiled with *akanwu* will have better protein digestibility, energy availability and then increased growth rate than those fed raw seed. This is because TI that binds irreversibly to proteolytic enzymes and making them unavailable for the breakdown of proteinhas been effectively inactivated.

Saponin and hydrocyanide (HCN) followed the same trend as L-Dopa and TI where the processed performed significantly (P<0.05) higher than the raw. Hydrocyanide was reduced from 8.62% in the raw to 1.92% (i.e. 77. 71% reduction) in the boiled and to 1.13% (i.e. 86.89% reduction) in the boiled with *akanwu*. The reduction of the HCN in the processed seeds can be attributed to its volatile nature (Oke *et al*., 1996) and its low boiling point (Montgomery, 1995). Saponin was reduced from 0.89% in the raw to 0.19% (i.e. 74.80% reduction) in the boiled and 9.15% (78.82%) in the boiled with *akanwu*. Among the anti-nutritional factors considered, saponin had the least reduction after processing. Bressani *et al.* (2003) concluded thatboiling alone was the best method for L-DOPA removal in *Mucuna* seeds, even with combinations of boiling, treating with sodium bicarbonate and soaking reduced L-DOPA.On the whole, boiling method is selected as the best method of detoxification for *Mucuna sloanei* seeds since it was able to make 84.18% reduction of L-DOPA which is the major anti-nutrient in *Mucuna* and 98.40% reduction of trypsin inhibitor a wide spread anti-nutrient among legumes. In addition it is amethod of detoxification that can be well adapted to by the local farmers as against that of boiling with potash (*akanwu*) which involves the preparing of potash solution and additional cost

Table 3: Levels of anti-nutritional factors in raw and processed *Mucunasloanei* seed meal.

Anti-nutrient factors (%)	Raw	Boiled	Boiled with akanwu	SEM
L Dopa	2.68[a]	0.42[b]	0.25[c]	0.39
% reduction of L Dopa		84.18	90.83	
Saponin	0.89[a]	0.18[b]	0.15[b]	0.12
% reduction of saponin		74.80	78.42	
Hydrocyanide	8.62[a]	1.92[b]	1.13[c]	1.13
% reduction of HCN		77. 71	86.89	
Trypsin inhibitor	23.67[a]	0.38[b]	0.17[c]	3.89
% reduction of TI		98.40	99.30	

Means within the same row with different superscripts ([a] –[c]) are significantly (P< 0.05) different .SEM- Standard error of mean

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